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ABSTRACT

This study documents the employment patterns and demographic characteristics of recent PhDs in earth and space science. It summarizes the latest annual survey of recent earth and space science PhDs conducted by the American Geological Institute, the American Geophysical Union, and the Statistical Research Center of the American Institute of Physics. This survey was completed by 223 new PhDs. Job market indicators for 2001 showed that the job market for recent PhDs in the geosciences is basically as strong as any in the previous 5 years. Starting salaries were up in every employment sector, and starting levels for postdoctoral appointments remained at the same level as 2000. Of the PhD class of 2001, 78% found work in the earth and space sciences, and 98% were employed in science or engineering. Time spent looking for initial employment remained low, and 10% of new PhDs over the past 6 years had been employed for at least 1 year by the time they received their doctorates. PhDs in the earth and space sciences remain, as a group, the oldest among all of natural sciences and engineering PhDs. This characteristic could be attributed to the delay between earning a bachelor's degree and beginning graduate school, rather than spending more time in school. (SLD)

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Earth & Space Science PhDs, Class of 2001

This study documents employment patterns and demographic characteristics of recent PhDs. It summarizes the latest annual survey of recent Earth and space science PhDs conducted by the American Geological Institute (AGI), American Geophysical Union (AGU), and the Statistical Research Center of the American Institute of Physics (AIP). Highlights of the results include the following:

- Job market indicators for 2001 show that the market for recent PhDs in the geosciences is basically as strong as any in the previous five years. Starting salaries are up in every employment sector; starting salaries for postdoctoral appointments remained at the same level as 2000.
- Of the PhD class of 2001, 78% found work within the Earth and space sciences and 98% were employed in science or engineering.
- Time spent looking for initial employment remained low for the fourth year in a row, with an average of 3.6 months—up slightly from 3.4 months in 2000. In 1998, graduates spent an average of 5.5 months looking for a job. In 1999, the average was 4.7 months.
- Ten percent of new PhDs over the past six years had been employed for at least one year by the time they received their doctorates. Their age, work experience, and salaries differ substantially from those finding initial employment after graduation.
- PhDs in the Earth and space sciences remain, as a group, the oldest among all of the natural sciences and engineering, according to the National Science Foundation. Our survey found that this characteristic can mostly be attributed to the delay between earning a bachelor's degree and beginning graduate school and not due to students spending more time in school.

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Introduction

The American Geophysical Union (AGU) and the American Geological Institute (AGI) have been collecting data on recent PhDs in the geosciences for six years. Each year, letters are sent to Earth and space science departments requesting addresses of their recent PhD graduates. The graduates are then contacted directly and asked to answer questions about their education and employment specialties, information on efforts to find their first job, experiences in graduate school, as well as demographic information.

The National Science Foundation Survey of Earned Doctorates reported a total of 749 PhDs in the Earth and space sciences in 2001. We sent surveys to 347 doctorates, of whom 223 responded, for a response rate of 64%. This report does not include new PhDs who left the US or those who earned their degrees from departments that do not have a geoscience term in their name.

In 1996 and 1997, the data were collected as part of a multidisciplinary effort coordinated by the Commission on Professionals in Science and Technology (CPST) and sponsored by the Alfred P. Sloan Foundation and the National Science Foundation (NSF). Since 1998, AGU and AGI have continued the effort with their own funds and included additional questions to provide a more complete picture of the graduates. This report draws on the results of the surveys of six PhD classes (1996 to 2001) in the Earth and space sciences as well as data from the NSF.

The Job Market

Over the last six years, a general improvement has been recorded in the job market through indicators such as time to find employment and starting salaries. As these indicators continue to improve, so too does the perception of the job market in general. This change in perception has been documented. In 1996, about three-fifths of the recent graduates felt that the job market was hopeless or bad, and only 6% felt it was good or excellent. By 2001, only one-fifth found the job market bad and 30% believed it was in good shape for geoscientists (see **Figure 1**).

Over the past five years, the time to find employment has been decreasing steadily. In 1998, graduates spent an average of 5.5 months looking for a job. In 1999, the average was 4.7 months and by 2000, it was only 3.4 months. In 2001, the time spent seeking employment rose only slightly, to 3.6 months.

Figure 1. Respondent ratings of the PhD job market, 1996 to 2001

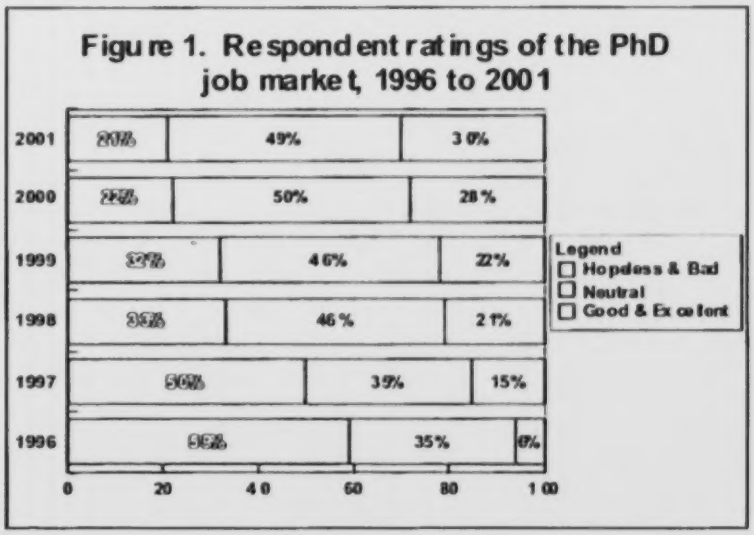

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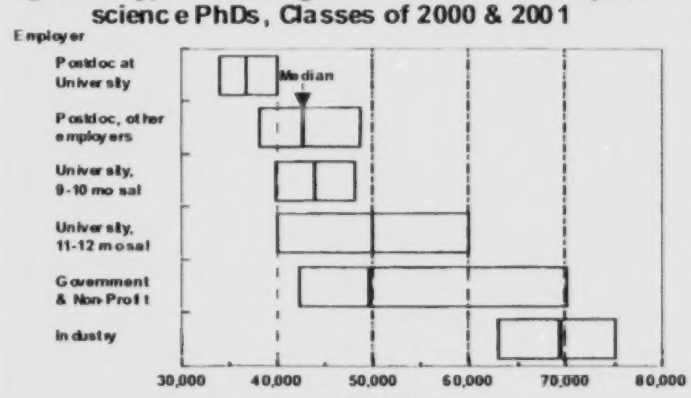
Figure 2 Typical starting salaries for Earth & space science PhDs, Classes of 2000 & 2001



Note: Typical salaries are the middle portion of the range of salaries reported, i.e., 25th to 75th percentiles

Starting salaries for permanent employment have increased over the previous year's levels in all areas (postdoc salaries for 2000 and 2001 remained the same). **Figure 2** shows the range of typical starting salaries by employer category (note the large salary range for government and non-profit sector). (Refer to **Appendix, Table A1** to see which types of employment are included in the three major sectors mentioned throughout this report.)

While 12% of non-postdoctoral respondents are currently working in government, about half of these government workers have been employed for more than one year. Because the salaries reported from these workers are not true starting salaries, their data are not included in Figure 2 (see methodology section for details). For the government workers already employed while in graduate school, the median salary for the class of 2001 was $61,000.

In response to the question "What would have been the most helpful in your career planning?", fully half of the respondents indicated some level of dissatisfaction with their department and/or university role in their career preparation. Most cited a desire for more effective and informed mentoring and advising, contact with recently employed graduates, and general career information and preparation (especially for the non-academic workplace). About a quarter wished they had acquired more skills and training in computers and writing (especially grant-proposal writing).

Finding work: Where and How?

Geoscientists can head down a variety of career paths upon receiving their PhD. They may find permanent employment, or they may obtain a postdoctoral position. Postdoctoral appointments are defined as temporary positions in academe, industry, or government; they primarily provide continued training or education in research. The class of 2001 had a slightly greater proportion of graduates taking postdocs than in the previous two years: 49%. Forty-six percent of the recent graduates are finding full-time permanent employment. The remaining 5% found other temporary (non-postdoctoral) positions.

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Table 1. Employment sector by postdoc status and year of graduation, 1996 to 2001

Postdocs	2001 %	2000 %	1999 %	1998 %	1997 %	1996 %
Academe	33	23	25	32	31	36
Government	13	15	12	11	6	5
Industry	1	1	1	-	1	1
Non-Profit	2	4	1	8	4	2
Non-Postdocs						
Academe	24	23	27	20	27	30
Government	11	14	17	8	10	13
Industry	15	19	16	20	19	11
Non-Profit	1	1	1	1	2	2
Number of Respondents	211	150	157	144	327	123

Note: A dash (-) indicates less than 1%

How PhD graduates find employment depends largely on the sector in which they wish to work and the type of position they want: postdoctoral or permanent. The method of job search cited as most effective varies from year to year. For those who gained academic employment, journal listings were the most effective resource. Those who went to work for the government (federal/state) found that some informal channel, such as a colleague or friend, was the most helpful. Those who went into industry used a placement service most often. (see **Appendix, Figure A2**).

Magazines and journals containing job openings were cited as most essential in the job search by 22% of respondents, while 15% said that their faculty advisor was their best link to finding employment. Electronic resources have also become increasingly important. Ten percent of PhDs said that this method, which may include professional society and employer job listings on the Internet, was the most effective. Another 7% found employment through a contact from a former job. Among all job search methods, informal channels were identified as the single most effective by 23% of respondents.

Interestingly, important differences were noted in the emphasis placed on particular job-searching strategies utilized versus their effectiveness in finding a job. For example, although more than 61% of postdocs relied on their advisors for assistance during the search, only about a quarter of the group felt their advisors had played the most important role in the process (see **Appendix, Figure A1**).

Academe is still the most popular employment sector for recent PhDs (see **Table 1**). More than half of all respondents work at universities. About one-sixth of the class of 2001 went to work in the industrial sector. Government employees make up another 24% of the working graduates. The increase in the percentage of those going into academic postdoc positions may reflect a tightened job market, especially considering the decrease in government postdoc employment (see **Figure 3** and **Table 1**).

Figure 3. Percent of Earth & space science PhDs working in postdoctoral positions after degree completion, 1996 to 2001

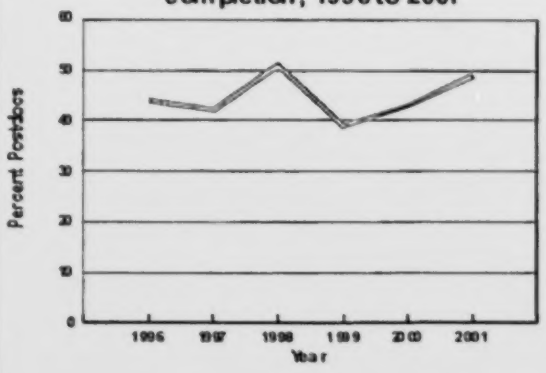

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Table 2. Percent of PhDs agreeing with qualitative statements about their careers, by postdoc status, 2001			
	Postdocs %	Non-Postdocs %	Overall %
My current position is commensurate with my education	100	94	97
My current position is related to my field	98	91	94
My current position is professionally challenging	99	88	93
My current position is similar to what I expected to be doing when I began my doctoral program	88	75	81
Number of Respondents	91	104	195

Respondents were asked to give their opinions on the extent to which they agreed with the above statements on a scale of 1 to 5 where 1=Strongly Agree, 3=Agree, and 5=Strongly Disagree. The above data reflect the percentage of respondents who chose 1, 2, or 3.

Graduates may be forced into postdoctoral positions when permanent employment is not available. As **Table 2** shows, postdocs still find their work substantively rewarding, slightly more so than non-postdocs.

Graduates are not limited to employment in the field of their doctoral dissertation. PhDs may find work in a different subfield, or in a field outside of the Earth and space sciences.

The vast majority (78%) of graduates find their first job in a geoscience field. Of those who leave the Earth and space sciences, 4% teach science, 3% work in computer science, and 2% are employed as engineers. Very few (2%) work outside of science and engineering.

What PhDs do greatly depends upon the sector in which they work. More than half (61%) of all respondents list their main work activity as "research." Of those employed in industry, 21% do research and another 21% do consulting, and 18% each are in professional services and in design, development, and engineering.

Table 3. Degree to which new PhDs use the following skills on the job, 2001				
	PhDs who often use these skills			
	Academe %	Industry %	Govt. %	All %
Cognitive skills (analytical thinking, problem solving)	86	94	94	89
Technical skills (computer skills, modeling & simulation)	87	79	91	86
Knowledge of principles that govern the physical world	86	62	83	81
Knowledge of dissertation field	71	41	66	65

Respondents were asked to rate the degree to which they use the above skills and knowledge on a scale of 1 to 5, where 1=Extensively and 5=Not at all. Those who chose 1 or 2 are said to use that skill, while those who chose 4 or 5 are said not to use that skill.

Table 4. Top reasons for considering dropping out of PhD program, 2001	
	%
Financial concerns	37
Poor relationship with advisor	26
Didn't feel intellectually capable	26
Family concerns and responsibilities	25
Poor job market	22

Note: This table is based on the 50% of respondents who indicated that they had considered dropping out of graduate school at some point. Respondents were asked to choose all reasons that applied. The above list represents the five reasons cited most often.

While the majority of respondents indicated that they used the skills learned in graduate school at work, there were substantive differences by employment sector. PhDs in industry are less likely than those in academe to use their knowledge of their dissertation field or their knowledge of principles that govern the physical world. Industrial PhDs are more likely to use cognitive skills but less likely to use technical skills than PhDs working at universities (see **Table 3**).

The Graduate School Experience

The most recent graduates had a more positive experience in school than did graduates five years ago. Half of the PhD class of 1996 thought about dropping out regularly or constantly. In the class of 2001, only one-tenth reported that they had considered dropping out of their PhD program regularly or constantly. The vast majority considered it only occasionally or never. The most common reasons cited for considering dropping out of graduate school were financial worries, poor relationship with one's advisor, doubt about one's intellectual abilities, and family responsibilities. A poor job market was also a source of concern (see **Table 4**).

When asked what they would change about their graduate school experience if they had it to do over, 32% said that they would change nothing. The changes suggested most frequently include taking more technical classes (25%), working in a different subfield (19%), working at a different institution (14%), and working with a different advisor (13%).

Respondents were asked to rate how strongly they agreed with the phrase "My advisor was helpful in my career planning," on a scale of 1 to 5 where 1 represents "extremely helpful," 3 is "helpful," and 5 "not at all helpful." Most (76%) respondents chose 1, 2, or 3. When asked similar questions about other sources of career support, 57% said that their scientific society was helpful, 49% agreed that their department was helpful, and only 34% found their university to be helpful.

Special Populations

There are several characteristics that are unique to PhDs in the geosciences. Unlike other physical science graduates, a significant number have been working full-time prior to earning their PhDs. Ten percent of geoscience graduates over the past six years started their current job more than one year before formally receiving their degrees. By way of comparison, new physics PhDs are half as likely as geoscience PhDs to have worked for one or more years prior to formally receiving their degrees. On average, these geoscience PhDs have been working for almost eight years by the time they finished their doctorates.

This tendency for finding employment prior to completing a PhD appears to be a positive trend in several respects. First, the majority of graduates in the geosciences incur little debt related to their education. Two-thirds accumulated no debt and only 11% owed more than $20,000.

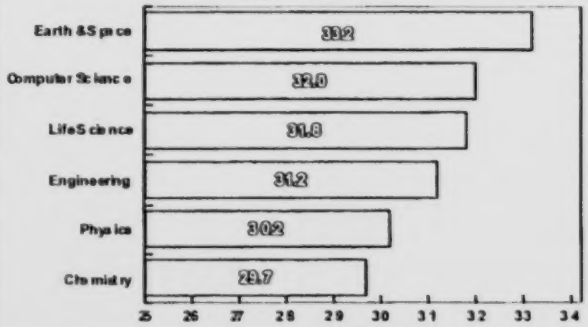
Table 5. Percent of those working at least one year prior to earning PhD by employment sector, 1996 to 2001						
	Postdocs %	University, 9-mo salary %	University, 12-mo salary %	Govt and non-profit %	Industry %	Overall %
Began position after earning PhD	100	93	85	60	87	90
Employed at least one year before earning PhD	-	7	15	40	13	10
Number of Respondents	502	149	106	152	196	1105

Second, PhDs employed while in school tend to have full-time salaries that are 37% higher than their counterparts finding initial employment after graduation. They are nine years older and start graduate school four years later on average than those who do not work, giving them the opportunity for more work experience.

Of those working full-time at least one year prior to earning their PhDs, almost half (40%) were employed in government, while 13% were in industry (see **Table 5**). The PhDs who were government employees while in school are concentrated in federal agencies, particularly the United States Geological Survey (USGS) and the National Oceanic and Atmospheric Administration (NOAA). Over this six year period, there were no discernible annual differences among those working prior to earning a PhD in the distribution across employment sectors.

Differences in employment subfield are also apparent for this group. Recent graduates employed prior to graduation are heavily concentrated in solid earth geology (30%) followed by atmospheric sciences (17%), hydrology and environmental science (13%), and oceanography (11%). (see **Appendix, Table A2** for a breakdown of subfields by category.)

Figure 4. Median age of PhD recipients by discipline, 2001



Source: National Science Foundation, Survey of Earned Doctorates, 2001

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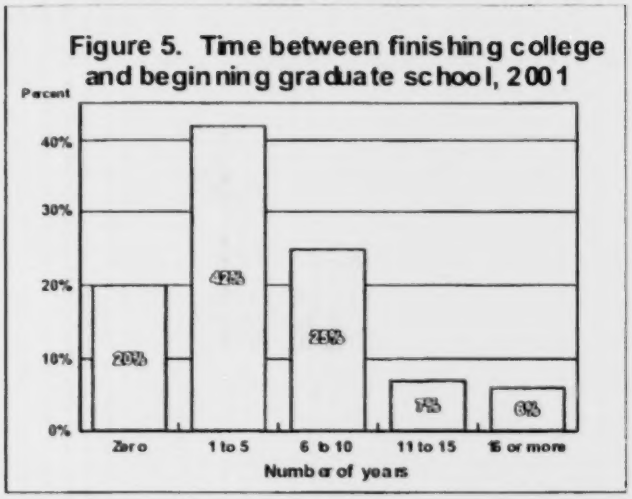

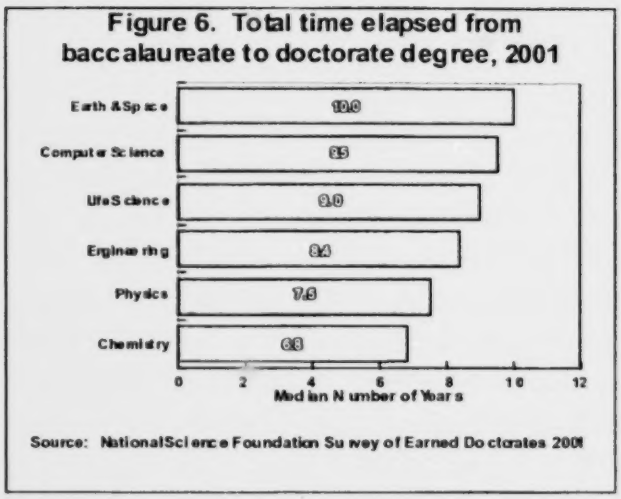

A second distinguishable feature of Earth & space science PhDs is their age. For each of the last several years, a steady and substantive number of graduates were over the age of 40: 16% in 1998, 20% in 1999, 23% in 2000, and 18% in 2001. The National Science Foundation reports the age of PhD recipients of all fields (see **Figure 4**).

These older graduates differ from younger PhDs in several respects. Those over 40 are concentrated in chemical earth science employment subfields (especially volcanology and geochemistry) and they are much less likely to take postdoctoral appointments. Of those who had been employed more than one year before finishing school, one-third were over 40.

Another distinctive characteristic of Earth and space science graduates is the length of time they spend in school and length of time they wait to begin graduate school. In 2001, the average time between earning a bachelor's and starting the graduate program from which they earned this PhD was 5.2 years. Almost a third (29%) of the graduates enter a PhD program less than two years after earning a bachelor's (see **Figure 5**).

A slightly higher percentage (38%) began their graduate study more than five years after receiving their bachelor's degree. Some worked during this delayed entry and some were in another graduate program before transferring into their final PhD program.

According to National Science Foundation data, because of the amount of time Earth and space science PhDs wait to begin school, coupled with employment for some during periods of graduate work, Earth and space science students allow the most time to lapse (10 years) between earning their undergraduate degrees and their PhDs (see **Figure 6**).

Table 6. Average number of years spent in graduate school by length of time between bachelor's granted and grad school started

Number of years between undergraduate and graduate school	Number of years in PhD program
Zero to 1 years	6.3
2 to 5 years	5.8
6 to 9 years	5.8
10 or more years	5.9

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Although many PhD students in the Earth and space sciences are delaying entry into graduate programs, the amount of time spent earning a doctorate does not vary by how long one waits (see **Table 6**). Students waiting six or even ten years after completing a bachelor's degree appear to spend about the same amount of time working towards a doctorate as those who began graduate school immediately after their undergraduate program. The average time spent in a PhD program among all students was six years.

Gender

Women in Earth and space science are under-represented compared to the general population. However, the representation of women among geoscience PhDs is high compared to several other physical sciences.

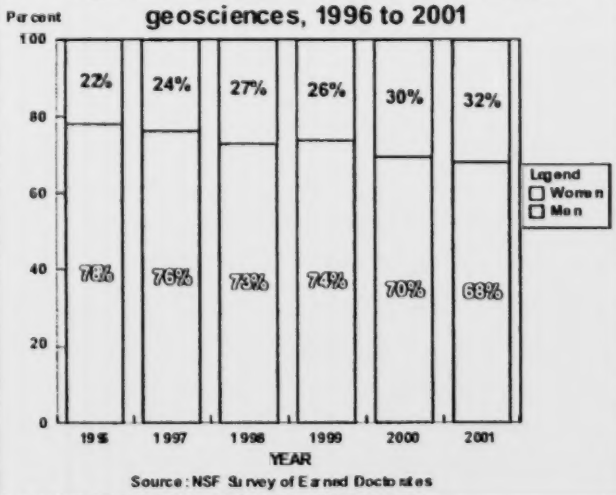
Our study found that each PhD class from 1996 to 2001 had graduated only between one-quarter and one-third women (31% in 2001) This is comparable to data from the NSF Survey of Earned Doctorates, which showed 31.5% for 2001 (see **Figure 7**).

While this is not comparable to the proportion of women in the general population, it is among the higher of the scientific disciplines in granting PhDs (see **Figure 8**). Only the life sciences and chemistry produce a higher proportion of female science PhDs than the Earth and space sciences. Computer science, physics, and engineering have the lowest concentrations of women, with 16% or less each.

The women who graduated with a PhD in 2001 reported employment characteristics similar to those of their male colleagues, with no substantial gender differences for any of the items we surveyed. Average salaries are not significantly different. The amount of time reported to finish school and to find a job were virtually identical for both sexes.

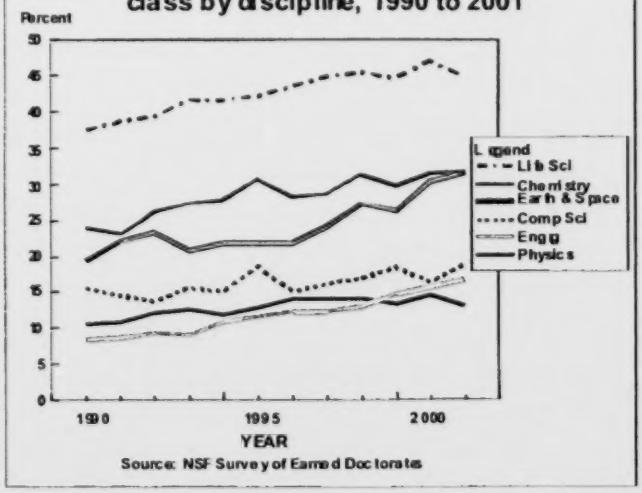
This equity in employment characteristics is encouraging news for current female graduate students. The overall number of female graduates has increased from 19% in 1990 to almost 32% in 2001.

Figure7. Gender of recent PhDs in the geosciences, 1996 to 2001



Source: NSF Survey of Earned Doctorates

Figure 8. Proportion of women in PhD class by discipline, 1990 to 2001



Source: NSF Survey of Earned Doctorates

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APPENDIX

Methodology

In September 2001, 203 PhD-granting Earth and space science departments received a request for the names and addresses of students who earned a PhD between July 2000 and June 2001. Those who did not respond received a second request in January 2001 and a third in March. By April, 126 departments replied, yielding a 62% response rate.

Questionnaires were sent to 360 recent PhDs between January and April. Of these, 13 were returned to us due to problems with the mailing address. PhDs who did not respond received a second request four to seven weeks after the first mailing. Of the 347 PhDs with valid addresses, 223 responded, for a response rate of 64%.

Because PhDs in the Earth and space sciences are not all granted by departments in geology and similar fields, we amended our data with that collected by the American Institute of Physics (AIP) in their study of recent PhDs from physics departments. Twenty-nine space science PhDs from their study were included in our analyses. The questionnaire used for AIP's study omitted several questions included on ours. Of the data taken from the AIP survey of physics departments, the questions used in ours were worded identically.

Because the date some students indicated as their degree date differed from that which their institutions stated, we had some discrepancies between school reports and self-reports. We relied upon the student's statement, but expanded our window to include degrees completed between April 2000 and October 2001. Eighteen students were excluded from the analysis because they received their degrees outside of this range. Six respondents from last year's study have been included in the current analysis because they received their PhD after October 2000. They were not included in the analysis of the previous report, Earth & Space Science PhDs, Class of 2000 (Giesler, et al) published October 2001.

A total of 240 PhD recipients for 2001 are included in the analysis of this report. Data are excluded only as a last resort when the information provided by the respondent either is not comparable to the aspect under study or does not make sense given other factors. Twenty-two who have been working at their current job for more than one year were excluded from all salary analyses to restrict such results to starting salaries. Our focus is on initial employment in the US only.

Table A1. Types of employment included in each of the employment sectors

Category	Employment areas included
Industry	Multinational corporations
	Large companies
	Small consulting firms
	Self-employed workers
Academe	Four-year colleges or universities
	Two-year colleges
	Elementary or secondary schools
Government	Federal agencies
	National laboratories
	State and local governments

Note: People working at non-profit agencies are included with government employees unless otherwise specified.

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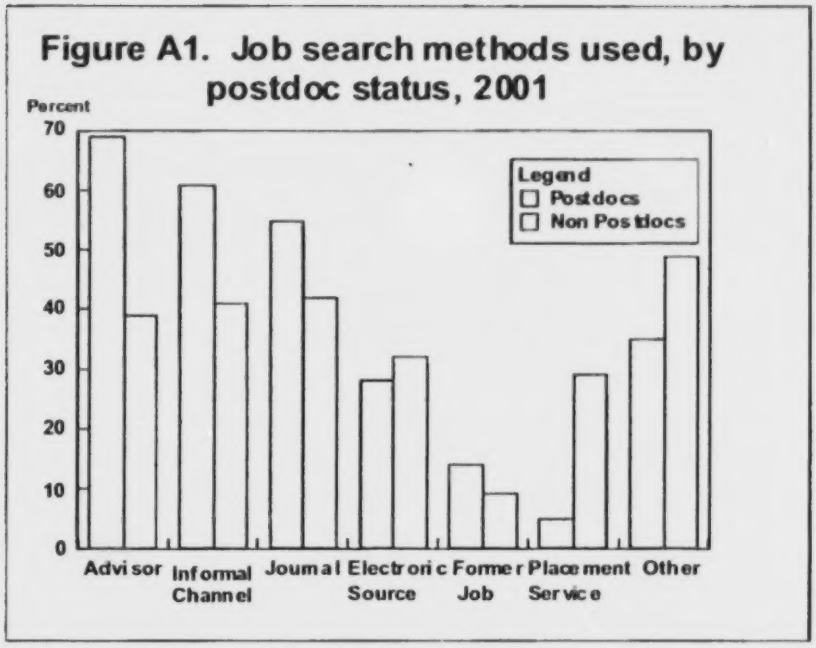
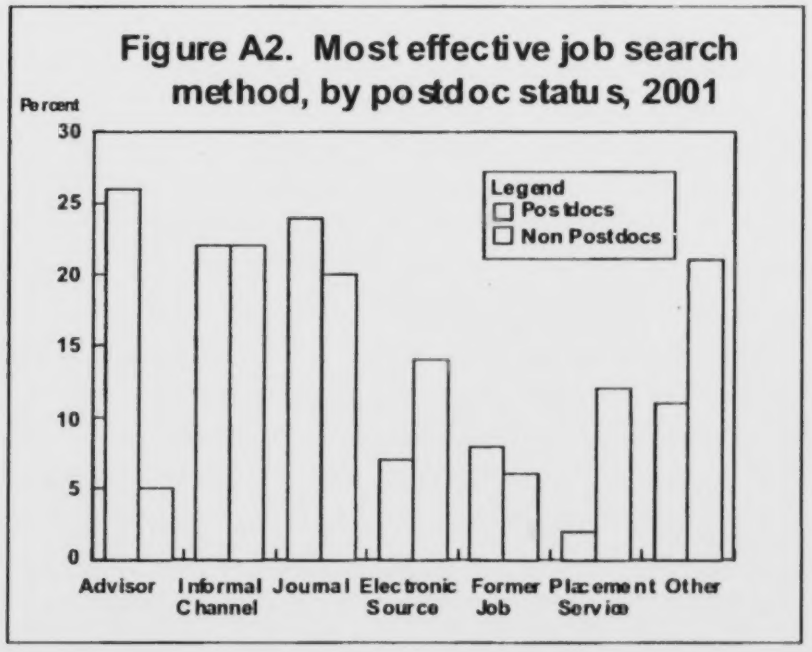
Table A2. Breakdown of subfields by category	
Category	Subfields included
Atmospheric Sciences	Atmospheric Sciences Meteorology Climate Studies Global Earth System Science
Hydrology and Environmental Science	Hydrology Water Resources Soil Science Geomorphology
Oceanography	Physical, Chemical, & Biological Oceanography Geophysics Sea Floor Processes Marine Geology Ocean Engineering Coastal Science Fisheries
Solid Earth Geology	Paleontology Sedimentology Stratigraphy Structural Geology Tectonics Rock Mechanics Paleoscience Glaciology
Chemical Earth Science	Volcanology Petrology Mineralogy Geochemistry
Solid Earth Geophysics	Seismology Economic Geology Exploration Geophysics Other Solid Earth Geophysics
Space Science	Planetary Science Space Physics Aeronomy Astronomy
Other Science and Engineering	Engineering Computer Science Science Education Other Science Public Policy





Note: Respondents were asked to select all job search methods they used from a list of 11 choices. Figure A1 shows the most common job search methods used, while Figure A2 shows the job search methods that respondents felt were most effective.

"Other" includes newspaper advertisements, employment agencies, sending unsolicited vitae, receiving unsolicited offers, and mentors.

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